Bond Energy calculations

QUESTIONS: Carry out the following Bond Energy calculations

For additional information please use the values provided in the table below

Bond	Bond enthalpy kJ mol–1
C–H	413
H - H	436
C–O	358
O–H	463
C=O	745
O=O	498
C–C	348
C – Cl	339
N – H	391
C – N	286
H – Cl	431
N–N	163
N≡N	941

1) Complete combustion of methanol can be represented by the chemical equation below, use the bond enthalpies to calculate Δr*H* for this reaction.

$$2CH_3OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$$

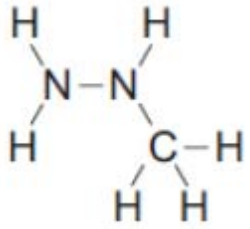
2) The equation for the combustion of ethanol is below, calculate the bond enthalpy for the O–H bond

$$CH_3CH_2OH(g) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g) \quad \Delta rH° = -1379 \text{ kJ mol}^{-1}$$

3) Calculate the enthalpy change for the reaction below using the bond enthalpy data in the table.

$$CH_3Cl(g) + NH_3(g) \rightarrow CH_3NH_2(g) + HCl(g)$$

4) Methylhydrazine, $N_2H_3CH_3$, can be used as a fuel. The structural formula for methylhydrazine is



(i) Define the term bond enthalpy.

(ii) Use the bond enthalpies given in the table below to calculate the energy released when one mole of methylhydrazine vapour is burned.

$$N_2H_3CH_3(g) + 2½O_2(g) \rightarrow CO_2(g) + N_2(g) + 3H_2O(g)$$

5) Calculate the enthalpy of formation of water in the gas state, $\Delta_f H°(H_2O, g)$

6) Carbon monoxide is reacted with steam to produce hydrogen gas.

$$CO(g) + H_2O(g) \rightarrow H_2(g) + CO_2(g) \; \Delta_r H = -41.2 \text{ kJ mol}^{-1}$$

The bond enthalpies for the carbon to oxygen bonds in CO2 and CO are different. Use the bond enthalpies and the enthalpy of the reaction to calculate the bond enthalpy of the carbon to oxygen bond in CO. Why are bond enthalpy values always positive? Explain the difference between the following bond enthalpies.

7) A fuel cell, such as that used on a space-craft, is similar to a battery. An example is the fuel cell that ‘burns’ hydrogen and oxygen to produce water and energy.

The overall equation for the reaction is

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(l)\ \Delta rH^\circ = -572\ kJ\ mol^{-1}$$

If the water produced is in the gas phase the equation for the reaction is

$$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$$

Use the bond enthalpies to calculate $\Delta_r H^\circ$ for this reaction. Write an equation for which the enthalpy change is equal to $\Delta_{vap}H^\circ (H_2O)$.

By considering the nature of the reaction in part (b), describe why it is an endothermic change. Using the information in parts above, calculate the value of $\Delta_{vap}H^\circ (H_2O)$.